REMARKS

Claims 1-17, all the claims pending in the application, stand rejected. Claims 2 and 3 are amended so that each is in independent form.

Drawings

Applicant respectfully notes that the Examiner has not acknowledged receipt and acceptance of the drawings originally filed in the application on March 19, 2006. Acknowledgement and acceptance is respectfully requested. In the absence of an indication of such acknowledgment and acceptance, Applicant will assume that all drawings have been received and are acceptable.

Claim to Priority

Applicant respectfully notes that the Examiner has not acknowledged receipt and acceptance of the Applicant's claim to priority and the priority document, as originally filed in the application on March 19, 2006. Acknowledgement and acceptance is respectfully requested.

Claim Rejections – 35 USC 102

Claims 1, 3-8 and 17 are rejected under 35 USC 102(b) as being anticipated by Wright et al (6,016,285). This rejection is traversed for at least the following reasons.

The invention, as defined by independent claims 1 and 17, concerns an ultrasonic transmitting and receiving apparatus and method of transmitting and receiving ultrasonic waves by using an ultrasonic transducer, respectively. With regard to the apparatus, as illustrated in the block diagram of Fig. 1, the structure includes an ultrasonic transducer array 10, drive signal generating means 14, transmission control means 13 for controlling the drive signal generating means to form at least one ultrasonic beam, and a signal processing means 21 for performing reception focusing processing on plural detection signals obtained based on ultrasonic echoes received by the plural ultrasonic transducer so as to form a reception focal point in at least one region within the object to be inspected, thereby obtaining plural detection signals relating to the

at least one region. Claim 1 further specifies a storage means 31 for storing plural different **acoustic pressure intensity profiles**, which are set based on acoustic pressure intensity distribution formed by transmitting ultrasonic beams and reception focusing processing performed in the signal processing means. Finally, the apparatus includes a calculating means 32 for calculating image data relating to the at least one region on the basis of the plural detection signals related to the at least one region and the plural different **acoustic pressure intensity profiles**.

Method claim 17 recites several steps including (a) transmitting at least one ultrasonic beam by driving plural ultrasonic transducers and (b) performing reception focusing processing on plural detection signals obtained based on the ultrasonic echoes received by the plural ultrasonic transducers so as to form a reception focal point in at least one region within the object, thereby obtaining <u>plural detection signals</u> relating to the at least one region. Finally, there is a step (c) of calculating image data relating to the at least one region on the basis of (1) <u>the plural detection signals</u>, and (2) plural different **acoustic pressure intensity profiles.**

As explained at page 15, lines 11-18, the **acoustic pressure intensity profiles** represent acoustic pressure intensity or acoustic pressure intensity ratios in plural regions included in a surface where the ultrasonic beams reach <u>in a predetermined time elapsed from being transmitted</u>. Such surfaces are referred to as "isochronal surfaces." The intensity profiles are expressed by (1) the function of the position (directions) of the plural regions included in the isochronal surface and (2) the **acoustic pressure intensity** or **acoustic pressure intensity ratios** therein.

Thus, as explained at page 16 of the original specification, the plural **acoustic intensity profiles** are set based on (1) the transmitting directions of the ultrasonic beams and (2) the reception focusing processing of the ultrasonic echoes, specifically, receiving directions and depth of the reception focal points. Other factors for setting the acoustic pressure intensity profile include (3) a number of elements used from among the elements included in the ultrasonic transducer array 10, (4) an element pitch, (5) an aperture diameter of the used

elements, or (6) aperture conditions including a waiting factor within the aperture. The acoustic intensity profile is obtained by simulating an acoustic field based on these aperture conditions, transmission conditions including the transmission delay pattern, and reception conditions including the reception delay pattern. Alternatively, the acoustic intensity profile may be obtained by transmitting and receiving ultrasonic beams to the scattering phantom based on these conditions and using intensity ratios of ultrasonic echoes obtained by the measurement.

As explained at page 17, the essential data calculating unit (calculating means) 32 selects a profile from the plural profiles stored in the intensity profile storage unit 31 based on the transmitting direction and receiving direction set in the scanning control unit 11 and calculates image data with the suppressed side load components (essential data) based on the profile and measurement data corresponding to a selected isochronal surface from among sound data stored in storage unit 25. The image data is stored in storage unit 33. An image processing unit 34 then constructs two dimensional or three dimensional image data using the image data stored in storage unit 33, based on the calculations in essential data calculating unit 32. Such processing includes gain adjustment, contrast adjustment, gradation processing, response enhancement processing, interpolation processing, as well as scanning conversion on the image data.

The relationship between the **acoustic pressure intensity profile** and the transmitted waves may be understood with respect to the isochronal surfaces and corresponding lobes (local maximums) in the acoustic field that are illustrated in Figs. 2A and 2B, respectively, and explained at pages 17 and 18. As illustrated in Fig. 4 and described at page 19, intensity profiles are obtained by actually transmitting ultrasonic beams and performing reception focusing on the received echoes and then multiplying the transmission beam profiles and reception profiles. The illustration in Fig. 4 is of **acoustic pressure intensity ratios** corresponding to three lobes determined by a transmission beam and reception beam. The acoustic pressure intensity ratios (α_A, $\alpha_{B, \ldots}$), which are obtained in advance, are combined in simultaneous linear equations with measurement data Y_A, Y_B, Y_C to obtain essential data X_A, X_B, X_C. As explained at page 20, by performing such calculation with respect to all of the isochronal surfaces while varying the

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transmitting directions of ultrasonic beams, essential data can be estimated with respect to all of the regions within the given space. An example of estimating essential data for five pieces of measurement data is given at pages 20 and 21. Consequently, in accomplishing a major goal of the invention, the estimation accuracy of the essential data is increased.

As explained at page 22, in order to increase the number of equations constituting simultaneous equations, plural pieces of measurement data relating to a predetermined region and plural different acoustic intensity profiles correspond to their acquisition conditions are used. For that purpose, one or all of the aperture conditions of the transducer array 10, transmission condition or reception condition of the ultrasonic beams are varied.

The method according to the first embodiment of the invention is described with reference to Figs. 1-4 and Fig. 7, which is a flowchart, beginning at page 23. Notably, at step S8, the essential data calculating unit 32 calculates essential data in a predetermined isochronal surface by using measurement data in the predetermined isochronal surface included in the sound ray stored in the secondary storage unit 25, and **acoustic intensity profiles** as illustrated in Fig. 4, stored in the intensity profile storage unit 31. The calculation of essential data is performed using simultaneous equations, as taught at page 25 and 26.

Wright et al '285

In framing the rejection of claims 1 and 17 at pages 2 and 3 of the Office Action, the Examiner appears to point to the acquisition and storage of "**coherent samples**" that retain phase and amplitude information as corresponding to the claimed pressure intensity profiles. A careful review of the definition of "**coherent samples**" and their use in Wright et al '285 would demonstrate that they are not **acoustic intensity profiles**.

First, with respect to the overall goal in Wright et al '285, a purpose is to overcome problems with prior art systems which compromise image quality in favor of frame rate by undersampling a field of view (col. 2, lines 4-19). This results in undesirable visible artifacts. As explained at col. 3, lines 12-59, this goal is achieved by using one or more simultaneously

formed received beams in combination with one or more simultaneously excited transmit beams, storage of coherent samples (i.e., samples that preserve relative amplitude and phase relationships among the signals and, before detection, synthesis of one or more new coherent samples, which are calculated using stored coherent samples associated with the plurality of distinct received beams. In this regard, interpolations (weighted summaries, etc.) and are extrapolations and their other computations with respect to stored coherent samples are used to synthesize the new coherent samples on synthetic scan lines that are specially distinct from the received scan lines and/or spatially distinct from the transmit scan lines and/or both. Thus, both acquired and synthetic coherent samples are detected, scan converted and displayed or recorded.

As described at col. 6, line 46, a **coherent sample** would not be an **acoustic pressure intensity profile.** First, the definition of "coherent" requires storage preservation or maintenance of sufficient information to characterize the relative amplitude and phase of the complex envelopes of two signals. The goal is to generate coherent samples on synthetic scan lines, so that increased frame rates may be achieved without the compromise of image quality and resolution. Synthetic scan lines are defined at col. 6, line 28 as lines distinct from received scan lines and transmitted scan lines. As explained beginning at col. 6, line 65, the invention in Wright et al '285 uses increased image sample density with correction for geometric distortion. The preferred embodiment, as explained beginning at col. 7, line 11, requires sampling, digitization and storage of signals from multiple received beams, acquired simultaneously pairwise, each pair associated with a single transmit beam. The signals are digitized and stored in coherent form prior to any processing. The preferred technique for obtaining **coherent samples** is through quadrature or complex demodulation of the bandpass signal, as explained at lines 25-41. Alternative techniques involving combining beams or generating synthetic scan lines are further described at lines 42-67.

On the basis of the definition of **acoustic intensity profiles**, the **coherent samples** would not correspond to such components. At the least, the intensity profiles represent acoustic pressure intensity or acoustic pressure intensity ratios based upon an isochronal surface. There is

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no teaching or suggestion in Wright et al '285 that an isochronal surface is important or even relevant to a **coherent sample**. This definition is given in claim 2 of the present application and, by virtue of the Examiner's own admission, is not taught in Wright et al '285. Indeed, none of the synthesis techniques described by Wright et al '285 relating to samples synthesized on synthetic scan lines (col. 6, line 60), synthetic aperture scan (col. 11, line 40), samples synthesized in azimuth (col. 12, line 56), sample synthesized in range (col. 13, linen 25) or alternate embodiments for synthesizing samples in azimuth and range (col. 14, line 9), teach or suggest the use of **acoustic intensity profiles**.

Moreover, nothing in Wright et al '285 teaches or suggests a calculating means for calculating image date on the basis of signals relating to at least one region and plural different acoustic pressure intensity profiles. Thus, this feature of claim 1 and the further defined features of the calculating means in claims 4-8 are not found in Wright et al '285.

Similarly, with respect to claim 17, none of the features in step (c) are found in Wright et al '285.

Claim 3 has been placed into independent form and would be patentable for reasons given for parent claim 1. The claim further provides that the transmission control means of claim 1 controls said drive signal generating means such that plural ultrasonic beams are transmitted simultaneously in plural directions.

Claim Rejections – 35 USC 103

Claims 2 and 16 are rejected under 35 USC 103(a) as being unpatentable over Wright et al (6,016,285) in view of Wright et al (6,110,116). This rejection is traversed for at least the following reasons.

Claim 2 has been placed into independent form and would be patentable for reasons already given for claim 1. Moreover, claim 2 further specifies that the plural different **acoustic pressure intensity profiles** represent one of acoustic pressure intensity and acoustic pressure intensity ratios in plural regions included in an isochronal surface. The claim defines such

surface as one where ultrasonic beams reach in predetermined time elapsed from being transmitted. Claim 16 depends from claim 2 and further adds correction means for correcting acoustic pressure intensity profiles corresponding to a second isochronal surface.

The Examiner admits at page 5 of the Office Action that Wright et al does not explicitly disclose signal reception in plural regions in an isochronal surface. This admission does not go far enough since the rejected claims do not simply refer to signal reception but specifies that the different acoustic pressure intensity profiles are based upon intensity or intensity ratios included in an isochronal surface. As already noted, Wright et al '285 does not teach or even suggest acoustic pressure intensity profiles. Clearly, on the basis of the Examiner's admission, there is no teaching of such profiles that are based upon an isochronal surface.

The Examiner looks to Wright et al '116 for disclosure of signal reception at multiple isochronal surfaces, with reference to the sampling of data at plural focal depths along each scan line as illustrated in Fig. 1 and the separation of transducer array signals into data representative of multiple individual beams, as described at col. 10, lines 41-50 of the reference. The Examiner asserts that Wright et al '116 exploits multi-beam transmit and multi-beam received capability to achieve and store coherent (pre-detection) samples of received beam data along actual scan lines and performs interpolation of the stored coherent samples to synthesize new coherent samples at new range locations along existing scan lines or along synthetically created scan lines, with reference to cols. 15-16, lines 65-67 and 1-6. The Examiner considers it obvious to combine the two references, as stated at page 7 of the Office Action.

As already noted, Wright et al '116 does not concern **acoustic pressure intensity profiles** and, by the Examiner's own admission in asserting combinability of Wright et al '285 and Wright et al '116, concerns the same approach to creating synthetic scan lines. As described at col. 10, line 14, the illustrations in Figs. 1A and 1B, which are relied upon by the Examiner, depict transmit and received scan lines (solid) and straight-line signal propagation paths from individual elements (dashed), respectively. Fig. 1A illustrates the transmit beam former T-50 that sends appropriately time-delayed electrical signals to the individual transducer elements T-

54, which convert electric signals into acoustic waves that propagate into body tissue T-50. The transmit beam former T-50 generates simultaneous multiple beams along different scan lines, or different focal depths along the same scan line, but each of the multiple beams only scans the specified section of the image format. Fig. 1B depicts the digital received beam former R-58, which obtains the received scan lines R-64, R-66 corresponding to a dynamically focused first received beam and a dynamically focused second received beam, respectively. The beams are sampled in range at a plurality of focal depths (r1, r2, r3) along each scan line.

Contrary to the Examiner's assertion, Fig. 1A does not show an isochronal surface, but merely shows beams transmitted to different focal points r1, r2. Given the definition of "isochronal surface", it is clear that no such surface is shown, as the points are reached by a transmitted beam at different times. Fig. 1B illustrates samples at a plurality of focal depths, but this illustration is not relevant to an "isochronal surface," because it is not concerned with transmission of plural beams at a similar duration of time. Thus, even if the Examiner may be correct in asserting that the references are combinable (which Applicants do not admit), they simply have nothing to do with the present invention and, in particular, have no teaching of stored **acoustic pressure intensity profiles** that are based upon an isochronal surface.

For the foregoing reasons, claims 2 and 16 would be patentable and claim 16 would be further patentable since there is no teaching of the claimed correction means.

Claims 9-15 are rejected under 35 USC 103(a) as being unpatentable over Wright et al (6,016,285) in view of Clark (5,976,089). This rejection is traversed for at least the following reasons.

At pages 8 and 9 of the Office Action, the Examiner admits that Wright et al '285 does not disclose six different claimed features in dependent claims 9-15. Fundamentally, as stated at page 8 of the Office Action, Wright et al does not disclose calculating image data by obtaining a solution to simultaneous equations which have image data relating to at least one region as unknown and are constructed based on the plural detection signals relating to at least one region. The Examiner looks to Clark for a disclosure in step 114 of simultaneous linear equations to

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calculate interpolation coefficients used by interpolators shown in Figs. 3 and 3A of the reference.

The Examiner states that these equations specify the goals of balancing the resulting beams formed by interpolating two roundtrip beams that are identically aligned and are formed from two transmit beams emitted along two neighboring transmit lines. The Examiner asserts that the interpolation coefficients can be used for optimizing a selected characteristic of the image, the select characteristic being a beam profile of the interpolated beam, with reference to col. 9, lines 43-53. The Examiner asserts it would have been obvious to combine the method and apparatus for coherent image formation in Wright et al ‘285 with the matrix calculations for use in predimensional ultrasound as disclosed by Clark ‘089. The motivation stated by the Examiner is to perform “the most stable matrix computations on the received data using the most stable calculating methods.”

First, Applicant would note that Clark et al does not remedy the deficiencies of Wright et al ‘285. While the reference does mention “intensity profile” of a roundtrip beam at col. 6, lines 42 - col. 7, line 3, there is no teaching or suggestion that plural such intensity profiles should be stored or should be used for calculating image data, as claimed.

Second, the purpose of the arrangement in Clark is to have an imaging system 10 that emits a transmit beam along a transmit scan line and in response synthesizes several received beams. Clark wishes to reduce the number of transmit beams emitted so that the imaging system can increase the acquisition rate without reducing the predetermined resolution. As illustrated in Figs. 4A and 4B, multiple received beams may be synthesized for each transmit beam emitted along a transmit scan line. As explained at col. 9, line 24, with reference to Fig. 5A and the beam plot in Figs. 7A-7C, each roundtrip beam plot is a list of complex numbers, which specify the amplitude and phase of the synthesized signal received from a hypothetical point targeted at various lateral angles at the specified depth of 16 cm. A goal is to interpolate the beams and beam magnitudes are used to compute the interpolator coefficients, so that easy linear algebra can be used. The beam magnitudes are used to build a matrix equation based on a set of

simultaneous linear equations. Notably, as is expressly stated in Clark, the matrix relies upon beam magnitude measurements and the solution of the simultaneous linear equations is a set of interpolation coefficients used by the interpolators shown in Figs. 3 and 3A. As explained at col. 9, lines 43 - col. 10, line 13, the coefficients are used for optimizing a selected characteristic of the image, which may be a beam profile. Thus, the interpolated beams have substantially similar profiles both under normal conditions and with an aperture half blocked.

Notably, the subsequent teachings of the solution of simultaneous equations have nothing to do with the use of already established and stored **acoustic pressure intensity profiles** in combination with measurement data to calculate image data, as explained at page 17 of the present specification. Indeed, Clark's concern is with a calculation of coefficients themselves, rather than data. Moreover, the coefficients are not subsequently used in a matrix application, as in the present invention. Thus, even if the two references were combinable (which the Applicant does not concede), nothing in Clark would teach the use of acoustic pressure intensity profiles in the manner claimed.

Finally, the Examiner's explanation as to why one of ordinary skill in the art would combine Wright et al '285 with Clark demonstrates an impermissible use of hindsight. Once again, Clark is concerned with the generation of coefficients by the solution of the simultaneous equations. Nothing in Clark or Wright et al '285 teaches or suggests why such coefficients might be useful for the system taught by Wright et al. There is no relationship to the generation of coherent signals or synthetic scan lines, which is the focus of Wright et al.

To the extent that the Examiner is suggesting that Clark teaches a way of using simultaneous linear equations to solve certain issues in ultrasonic devices, this is not the focus of the present invention. Applicants claims are not that broad but instead are directly focused on the generation of image data relating to at least one region on the basis of plural detection signals relating to the at least one region and the plural different **acoustic pressure intensity profiles**.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the

Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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